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Sudden infant death and social justice: A syndemics approach

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Abstract

Sudden unexpected infant death (SUID) and sudden infant death syndrome (SIDS) prevention has focused on modifying individual behavioural risk factors, especially bedsharing. Yet these deaths are most common among poor and marginalized people in wealthy countries, including U.S. Blacks, American Indians/Alaskan Natives, New Zealand Māori, Australian Aborigines, indigenous Canadians, and low-income British people. The United States now has the world's highest prevalence of SUID/SIDS, where even Whites' SIDS prevalence now approaches that of the Māori. Using public databases and the literature, we examine SUID/SIDS prevalence and the following risk factors in selected world populations: maternal smoking, preterm birth, alcohol use, poor prenatal care, sleep position, bedsharing, and formula feeding. Our findings suggest that risk factors cluster in high-prevalence populations, many are linked to poverty and discrimination and have independent effects on perinatal outcomes. Moreover, populations with the world's lowest rates of SUID/SIDS have low income-inequality or high relative wealth, yet have high to moderate rates of bedsharing. Employing syndemics theory, we suggest that disproportionately high prevalence of SUID/SIDS is primarily the result of socially driven, co-occurring epidemics that may act synergistically to amplify risk. SUID must be examined through the lens of structural inequity and the legacy of historical trauma. Emphasis on bedsharing may divert attention from risk reduction from structural interventions, breastfeeding, prenatal care, and tobacco cessation. Medical organizations play an important role in advocating for policies that address the root causes of infant mortality via poverty and discrimination interventions, tobacco control, and culturally appropriate support to families.

KEYWORDS

breastfeeding, infant mortality, infant sleep, SIDS, SUID, tobacco

1 | INTRODUCTION

Approaches to prevention of sudden unexpected infant death (SUID) and sudden infant death syndrome (SIDS) have historically emphasized individual behaviour change, most often focusing on bedsharing. Often overlooked in discussions about SUID, however, is that these deaths primarily occur among poor and marginalized people in wealthy countries. Compared with rates of SUID/SIDS in their general populations, markedly elevated rates have been found in U.S. Blacks, American Indians/Alaskan Natives (AIs/ANs), New Zealand Māori, Australian Aborigines, indigenous Canadians, and low-income British people (see below). In this paper, we draw on anthropological and social epidemiological insights to argue that instead of this individualistic approach, we need to consider the social origins, clustering or co-occurrence, and interplay of known risk factors (Ball et al., 2016; Singer, Bulled, Ostrach, & Mendenhall, 2017) in order to make progress in reducing infant deaths in high-risk populations.

1.1 | Definitions

SUID historically encompasses the following 10th Revision of the International Statistical Classification of Diseases and Health Related

Problems codes: SIDS (R95), Ill-defined and Unspecified Causes of Mortality (R99), and Accidental Suffocation and Strangulation in Bed (ASSB, W75). Overall, SIDS and SUID rates have fallen dramatically between 2002 and 2012 and beyond in many countries, with the United States being a notable exception (B. J. Taylor et al., 2015).

1.2 | Bedsharing and co-sleeping

We define co-sleeping as whenever mother and infant are sleeping within physical contact of one another. In this paper, the word co-sleeping may encompass bedsharing, but we will use bedsharing to specifically mean a mother sharing an adult bed with her infant.

1.3 | Physiological basis for infant deaths associated with known risk factors

Below, we briefly review the physiological mechanisms by which smoking, prone sleep, formula feeding, preterm birth, and soft bedding such as sofas increase risk of death, independent of any sociological context, for example, poverty.

Smoking, both antenatal and post-natal, is thought to provide a physiological basis for death due to effect on serotonin (Duncan et al., 2009; Kinney, 2009), which affects arousal, recovery from hypoxia and hypercapnia, and thermoregulation. There is strong evidence of a dose-dependent effect of smoking and SIDS in combination with bedsharing, particularly in maternal post-natal smoking (Zhang & Wang, 2013). Prenatal smoking is associated with deficient hypoxia awakening responses (Lewis & Bosque, 1995) and attenuated recovery from hypoxemic challenges (Schneider, Mitchell, Singhal, Kirk, & Hasan, 2008). Antenatal smoking also increases the risk of preterm birth (Ion & Bernal, 2015), itself a risk for SUID.

Prone sleep position is associated with higher risk of death due to decreased arousability and possibly due to heat stress, as the face is important for dissipation of heat in infants (Kinney & Thach, 2009).

Preterm infants have a higher risk of SUID and SIDS inversely proportional to gestational age (Ostfeld, Schwartz-Soicher, Reichman, Teitler, & Hegyi, 2017). In addition to possible physiological factors, preterm infants are more likely to bedshare and to be placed prone to sleep (Colson et al., 2013; Hwang et al., 2015). Why preterm birth increases risk of SUID is poorly understood, and it is possible that the same risk factors that are responsible for the preterm birth may also be responsible for the increase risk of SUID/SIDS, such as smoking. Hypotheses include hypoxia related to immature lung function and lung and airway damage from mechanical or non-invasive ventilation (Garcia, Koschnitzky, & Ramirez, 2013). Apnoea of prematurity is not thought to be a factor (Schneider et al., 2008).

Soft bedding and sofas provide a risk of death due to asphyxiation (Blair et al., 2009). Alcohol or drug use may increase risk of asphyxiation by overlying as well as by falling asleep in hazardous bedding circumstances such as sofas (Blair, Sidebotham, Pease, & Fleming, 2014). Formula feeding is associated with an increased risk of SIDS (Vennemann et al., 2009), likely due to decreased maternal and infant arousals with decreased synchronization of mother–infant sleep (Mosko, Richard, & McKenna, 1997). Breastfeeding beyond 2 months is associated with a lower risk of SIDS in a dose-dependent fashion (Thompson et al., 2017). Videographic data show bedsharing positions in formula feeding dyads which are more likely to be hazardous (Ball, 2006), although other data show no increased risk of death from bedsharing and formula feeding if no other risks are present (Blair et al., 2014).

Key messages

- SUID and SIDS are primarily conditions of poor and marginalized people with legacies of historical trauma living in wealthy countries.
- Syndemics theory highlights the social origins, clustering, and potential interaction of risk factors like poverty, marginalization, preterm birth, and smoking.
- Emphasis on bedsharing is misplaced, as low-prevalence populations have high to moderate rates of bedsharing.
- Comprehensive approaches to infant mortality are needed that address poverty, inequity, and racial discrimination and include structural interventions for smoking cessation and breastfeeding.
- Medical organizations should advocate for social equity as a means to health but have missed opportunities to do so.

1.4 | The complex contextual role of bedsharing—Potential risks and protective effects

Proximate sleep and breastfeeding are part of the same evolutionary system (Ball, 2017b). Anthropologists McKenna and Gettler (2015) coined the term "breastsleeping" to reflect the evolutionary and physiological integration of these activities. Co-sleeping with breastfeeding is the physiological norm for humans and other primates. In traditional societies all over the world, infants are carried by their mothers 24 hr a day, nursing at will and sleeping with them at night (Barry & Paxson, 1971). Co-sleeping, including bedsharing, plays a key role in facilitating breastfeeding and therefore contributes to the protective effects of breastfeeding for SUID/SIDS.

Routine bedsharing has no risk of SIDS compared with unintentional bedsharing (Vennemann et al., 2012). There is debate over whether bedsharing poses an independent risk factor for SIDS. Blair et al. (2014) found that there is no additional risk in absence of other risk factors, whereas the American Academy of Pediatrics (AAP) has argued that bedsharing does pose an independent SIDS risk (Task Force On Sudden Infant Death Syndrome, 2016).

In some cases, bedsharing occurs in combination with other risk factors. For instance, many mothers bedshare even if smoking and/or formula feeding (Lahr, Rosenberg, & Lapidus, 2007). Although the independent role of bedsharing in these combinations is not always clear, some of these behavioural combinations are associated with increased risk (Blair et al., 2014; Lahr et al., 2007).

In turn, separate or solitary sleep also carries risk of early weaning (Huang et al., 2013) and stress to the infant. Infant cortisol levels

remain high when infants are separated from their mothers at night, and maternal–infant cortisol asynchrony occurs (Middlemiss, Granger, Goldberg, & Nathans, 2012).

1.5 | SUIDS/SIDS prevention and bedsharing

Much attention has been given to SUID/SIDS and bedsharing, as infants have often been found dead while sleeping next to an adult, either in a bed or in a sofa or recliner. As a result, numerous public health campaigns have strongly advised parents against bedsharing. U.S. public health campaigns have included scary images such as a tombstone replacing the headboard of the adult bed. Such anti-bedsharing advice, however, may have inadvertently contributed to adverse outcomes, including a fourfold rise in sofa deaths in the United Kingdom, as mothers fed infants on sofas and recliners at night in order to avoid bedsharing, then fell asleep there (Blair, Sidebotham, Berry, Evans, & Fleming, 2006; Kendall-Tackett, Cong, & Hale, 2010). Sofa sharing poses far greater risk than sleeping next to an infant in an adult bed (Moon & Task Force On Sudden Infant Death, 2016). Because bedsharing facilitates breastfeeding and is associated with greater breastfeeding duration (Ball et al., 2016; Huang et al., 2013; J. McKenna, Mosko, & Richard, 1997), advice against bedsharing also has profound implications for the health of both women and children (Bartick et al., 2017a; Victora et al., 2016). In response to a systematic assessment of the evidence, the United Kingdom has issued guidance that emphasizes the risks of smoking and sofa sharing, prioritizes room sharing, and encourages a contextual, informed choice approach about bedsharing (Ball, 2017a). In 2016, the U.S. AAP also issued guidance acknowledging similar risk factors but maintained a more authoritative, less nuanced anti-bedsharing stance (Ball, 2017a). For instance, it advised all parents to conduct night-time feedings in the adult bed but then to return the infant to a separate sleeping area (Task Force On Sudden Infant Death Syndrome, 2016). Despite a shift in medical guidance towards more complex conversations about prevention between health care providers and families, the framing of SUID/SIDS prevention continues to rely primarily on individual behaviour modification with little acknowledgement of the broader social context in which SUID/SIDS risk is produced.

1.6 | Conceptualizing social inequities and SUID/SIDS risk using syndemics theory

Poverty, racism, and other forms of marginalization have been identified as key social drivers of disease (Commission on Social Determinants of Health & World Health Organization, 2008). Previous literature from the United States and around the world has documented the role of poverty, racism, and other forms of marginalization in poor overall health as part of the emerging field of social determinants of health (Commission on Social Determinants of Health & World Health Organization, 2008) In the United States, a review of the literature has found that "weathering," the "chronic allostatic load generated by the continuing adaptation to enduring structures of inequalities" (Geronimus, 1992), generates—or at least contributes—to observed health disparities among Blacks (Dresslers, Oths, & Gravlee, 2005). Increased cortisol levels due to acute and chronic stress have been described as an effect of racism (Adam et al., 2015; Richman & Jonassaint, 2008) and may reasonably be expected to increase with effects of housing and food insecurity. Chronic stress among urban U.S. Black, but not Hispanic, pregnant women is associated with flattening of the diurnal cortisol curve (Suglia et al., 2010).

These socially produced stressors have significant implications for birth outcomes. Chronic stress between pregnancies is associated with flattening of the normal diurnal cortisol variation and is associated with a low-birthweight child in the subsequent pregnancy (Guardino et al., 2016). Maternal job strain is also associated with lower birthweight infants, and these effects are roughly doubled in U.S. Black women compared with U.S. White women (Oths, Dunn, & Palmer, 2001). Structural support can help mitigate some of these stressors. For instance, access to antenatal care is associated with lower infant mortality and lower rates of preterm birth (C. R. Taylor, Alexander, & Hepworth, 2005). Although housing insecurity may contribute to poor access to prenatal care, via multiple stressors and transportation issues (Desmond, 2016), targeted increased access to prenatal care to disadvantaged communities has been shown to reduce infant mortality (Meghea, You, Raffo, Leach, & Roman, 2015).

Social inequities contribute to negative birth outcomes including lower birthweight and preterm birth, which, in turn, influence the physiological risks of SUID/SIDS (Blair, Platt, Smith, Fleming, & Group, 2006). Poverty is associated with previously documented risk factors for SIDS in multiple settings, such as lower maternal educational level (Sosnaud, 2017), unmarried status, and younger age (Spencer & Logan, 2004). Structural barriers and stressors that are also reflected in behavioural risk factors for SUID/SIDS are often associated with lower socio-economic status: lower rates of breastfeeding, maternal smoking, and/or second-hand smoke exposure (Zhang & Wang, 2013), parental drug/alcohol use (Blair et al., 2014), sofa sleeping (Moon & Task Force On Sudden Infant Death, 2016), and nonsupine positioning (Moon & Task Force On Sudden Infant Death, 2016). Of these, smoking and/or alcohol combined with bedsharing are especially hazardous, as is sofa sharing.

Poverty is further implicated in poor access to prenatal care, which influences behavioural risk factors linked to increased risk of SUID/SIDS, because it deprives providers of opportunities to educate pregnant women in safe infant care practices such as avoiding soft sleeping surfaces, intervene in smoking cessation, and provide education and support for breastfeeding. Moreover, poor breastfeeding support post-natally is also more common in U.S. hospitals serving African American communities (Lind et al., 2014), further contributing to SIDS risk. Thus, there is a clustering of multiple risk factors in marginalized communities, many of which face multiple forms of oppression and discrimination.

Teasing out the specific pathways in which co-occurring risks develop over time and lead to their clustering is made particularly difficult because some risks are independently associated with one another. Smoking is independently associated with lower socio-economic status in the United States, Japan, and Northern Europe (Fukuda, Nakamura, & Takano, 2005; Kaneko et al., 2006; Loring, 2014) and is a cause of preterm birth (Wallace, Aland, Blatt, Moore, & DeFranco, 2017). Smoking is associated with early weaning (Liu, Rosenberg, & Sandoval, 2006). Alcohol use is associated with sofa

TABLE 1 Comparison of selected world populations by SIDS rates, SUID rates, and selected risk factors

Population	SIDS, ASSB per 1,000 live births (2002–2010)	SUID per 1,000 live births (2002–2010)	SIDS per 1,000 live births (most recent government figures)	SUID per 1,000 live births (most recent government figures)	Preterm birth (%) (2010)	Infant mortality rate per 1,000 live births (2013)	Any breastfeeding at 6 months (%)
Australia	0.31, 0.32	0.50	0.32 (2010), 0.07 (2015)	n/a	7.6	3.4	56 (2011), 60.1 (2010)
Australian Aborigine/ Torres Strait Islander (2.8% population)	n/a	n/a	0.6 (2008–2012)	1.2 (2008–2012)	12.6 (low birthweight, 2011)	6.2 (2008–2012)	45.4 (2010)
Australian non-Aboriginal	n/a	n/a	0.2 (2008–2012)	0.4 (2008–2012)	6.0 (low birthweight, 2011)	3.7 (2008–2012)	60.3 (2010)
Canada	0.33, 0.03	0.45	0.24 (2010), 0.06 (2013)	n/a	7.8	4.6	30 (2011–2012)
Indigenous Canadians (4.9% population: 58% First Nation, 35% Métis, 3.9% Inuit)	SIDS 2004-06: First Nation 2.2, Inuit 2.5	5.7–6.1 (1999–2011) Inuit in Nunavut	2.0 (2004–2006)	Does not collect	8.7 (2004–2006), First Nation 8.2, Métis 6.3, Inuit 11.4	9.6 (2004–2006), First Nation 7.5, Métis 7.1, Inuit 9.9	Initiation (2007–2010)–60.2–78.2
Canadian nonindigenous	2004-06 SIDS: 0.3	n/a	0.3 (2004–2006)	Does not collect	6.7 (2004–2006)	4.4 (2004–2006)	Initiation 87.8 (2007–2010)
Japan	0.20, 0.06	0.60	0.1 (2015)	n/a	5.9	2.1	63 (2009)
The Netherlands	0.10, 0.02	0.19	0.09 (2013), 0.04 (2015)	n/a	8.0	3.3	32 (2006–2008)
NZ	0.62, 0.34	1.01 (1.02 per NZ government)	0.30 (2012–14)	0.75 (2014)	7.6 (7.4 per NZ government)	5.2 5.7 (2014)	60 (2006), 26% exclusive/ full (2014)
NZ Māori (14.9% of population)	1.64	2.30 (SUID per NZ government)	0.45 (2012–14)	1.82 (2014)	8.1	7.2 (2014)	16% exclusive/full (2014–2015)
NZ non-Māori	0.39	0.51 (SUID per NZ government)	0.24 (2012–14)	0.34 (2014)	7.2	5.1 (2014)	30% exclusive/full (2014–2015)
Sweden	0.17 (2002–2011), ASSB rate too low to be reliable	0.34 (2002–2011)	0.18 (2013), 0.22 (2015)	n/a	5.9	2.4	52 (2010)
United Kingdom	0.28 (England and Wales), 0.02	0.45 (England and Wales)	0.18 (2014), 0.17 (2015) (England and Wales)	0.31 (2014), 0.27 (2015) (England and Wales)—See notes	7.8	3.9	34 (2005–2010)
United States	0.54 (0.53 CDC), 0.14	0.95 (0.95 CDC)	0.39 (2014)	0.87 (2014)	12.0	5.8 (2014)	49 (2011)
U.S. Blacks (13.3% of population)	1.01, 0.32	1.88	0.67 (2014)	1.85 (2014)	17.1	10.9 (2014)	35 (2011)
U.S. AI/AN (1.3% of population)	1.17, 0.33	2.15	0.88 (2014)	1.92 (2014)	13.6	7.7 (2014)	37 (2011)
U.S. Whites (76.9% of population)	0.53, 0.14	0.90	0.39 (2014)	0.82 (2014)	10.8	4.9 (2014)	52 (2011)
U.S. Hispanic (17.8% of population)	0.28, 0.06	0.53	0.24 (2014)	0.54 (2014)	11.8	5.0 (2014)	48 (2011)
U.S. Asian/Pacific Islander (Asian 5.7%; PI 0.2% of population)	0.23, 0.05	0.41	0.15 (2014)	0.29 (2014)	10.7	3.7 (2014)	71 (2011, Asian only)

Pregnancy smoking rate (%) (2010), female smoking rate (%) (2015)	Gini coefficient and quintile ratios per nation, (2010–2015)	Bedsharing as a cultural norm, at least sometimes (%)	Supine sleep as a cultural norm (%)	Alcoholic liver cirrhosis mortality in females per 100,000	Comments
11.7, 13.1 (male 16.7)	34.9, 6.0	30 (Brisbane)	No recent data available	2.0 (2010)	
49.3, 42 (2012–2013)		40 (South Australia)	8 (Perth)	20.3 (2008–2012, both sexes, "alcohol-related disease")	
12.1, extrapolate to 17.3 (2012–2012) (percentage of nonindigenous 18- to 24-year-olds)		30 (Brisbane)	No recent data available	3.9 (2008–2012, both sexes, "alcohol-related disease")	
10.5–23, 12.2 (male 17.7) (18.3 in 2006–2010)	33.7, 5.8	23 (Manitoba)	77	3.3 (2012)	

(Continues)

TABLE 1 (Continued)

Pregnancy smoking rate (%) (2010), female smoking rate (%) (2015)	Gini coefficient and quintile ratios per nation, (2010–2015)	Bedsharing as a cultural norm, at least sometimes (%)	Supine sleep as a cultural norm (%)	Alcoholic liver cirrhosis mortality in females per 100,000	Comments
Female smoking rates: 39.4-59.3 (Northern Territories 2006 and 2010); 34.2 (Métis), 39.1 (First Nation), 48.9 (Inuit) (2006–2010). Inuit women 73.6 (2012)		58–63 (Inuit), 100 among breastfeeding First Nation mothers (British Columbia, Manitoba, Ontario)	38-46 (Inuit Nunavut)	n/a	In First Nation families, family beds are common. Sofa sharing with fathers was described. Family beds may be piled high with blankets to stave off cold.
Nonindigenous pregnancy not known, 17.6 (2006–2010)		23 (Manitoba)	77	n/a	
5.1, 10.6 (male 33.7)	32.1, 5.4	37 (Tokyo/Yokahama). Likely underestimate: as only 16.9% pre-school children have their own bed	97	1.8 (2012)	Note high male smoking rate; families sleeping together and sibling bedsharing are common. Sleeping on futons is common.
6.2, 23.9 (male 26.2)	28.0, 4.5	40.4	84.6	1.7 (2012)	
18.4, no female data	33.5 (2010–2014, NZ government Gini)	19 (Dunedin)	72 (Auckland)	1.4 (2012), hazardous drinking, female 11.7%/male 27.2%	
31.6 (2009–2010), no female data		67.2 (includes Wahakura and Pepi-Pod)	No data	Hazardous drinking, female 18.8%/ male 34.3%	
6.8 (2009–2010) European, no female data		19 (Dunedin)	No data	European female 11.6%/male 27.5%	
4.9, 20.8 (male 20.4)	27.3, 4.2	65 (Stockholm), 44.2; 87.1 if breastfeeding (2012–2014)	84.4	2.0 (2012)	
12, 18.4 (male 19.9)	32.6, 5.3	32 (Scotland), 56 among breastfeeding, 84.4 (Bradford)	94.3 (White Bradford), 81.6 (Pakistani immigrants Bradford)	5.5 (2012)	
10.0, 13.6 (male 18.1)	41.1, 9.1	61.4 (24.4 often/always)	78.4	4.4 (WHO 2012), 3.9 (CDC 2010–2014)	
8.5, 13.3		76.4 (35.3 often/always)	62.4	2.6 (2010–2014)	Data suggest more common use of sofa-sharing compared with Whites. High rates of second-hand smoke.
17.1, 24.0		83.9 (56.1 often/always)	80.2	26.0 (2010–2014)	
13.9, 16.0		52.7 (17.5 often/always)	83.9	3.4 (2010–2014)	
2.0, 7.1		66.7 (28.7 often/always)	73.5	2.7 (2010–2014)	
1.3, 2.6 (Asian only)		76.8 (37.0 often/always)	79.2	0.5 (2010–2014)	

General notes

- AI/AN: American Indian/Alaskan Native; ASSB: Accidental Suffocation and Strangulation in Bed; CDC: Centers for Disease Control and Prevention; ICD: 10th Revision of the International Statistical Classification of Diseases; n/a: not available; NZ: New Zealand; PI: Pacific Islander; SIDS: sudden infant death syndrome; SUID: sudden unexpected infant death; WHO: World Health Organization.
- 2002–2010 data came from Taylor et al. (2015) for Australia, Canada, Japan, the Netherlands, the United Kingdom (England and Wales), and the United States (overall). Sweden's data (2002–2011) came from Möllborg, Wennergren, Almqvist, and Alm (2015). NZ data were calculated from Ministry of Health (2017a) using NZ government's definition of SUID, which is not spelled out. U.S. subpopulation data were calculated using the exact SUID ICD-10 definitions used by Taylor et al. (2015) using the CDC WONDER database using linked birth/death data (Centers for Disease Control and Prevention & National Center for Health Statistics, 2017).
- Recent government European SIDS rates came from Eurostat (2018).
- Most infant mortality data came from WHO (2015), except for subpopulations in the United States, NZ, and Canada.
- Preterm birth by country (2010) came from a joint report from the WHO (March of Dimes, PMNCH, Save the Children, & World Health Organization, 2012), except for subpopulations.
- Breastfeeding rates came from the appendix to Victora et al. (2016), unless otherwise specified for subpopulations.
- Most tobacco data came from WHO (2016), except for subpopulations.
- Gini coefficient and quintile ratios (indexes of income inequality) came from the United Nations Human Development Report 2016 (Jahan, Jespersen, & Human Development Report 2016 Team, 2016).
- Bedsharing at 3 months (Nelson et al., 2001) unless otherwise specified.
- Supine sleep data are reported by individual populations (see countries below).

- Mortality of alcohol use disorders of adult females came from WHO (2014) unless otherwise stated. It is calculated by taking using listed rates in their tables for age standardized death rates for liver cirrhosis and multiplying it by the alcohol attributable fraction of liver cirrhosis. See separate note for the United States.

Australian notes

- Australian Aboriginal population data came from the 2016 Australian census.
- Australian SUID in Aborigines and non-Aborigines was defined as SIDS plus "signs, symptoms, and ill-defined conditions" in the Australian Government Report for 2012–2013, which would imply R99 but not W75.
- Preterm data were not available for Australian Aboriginal infants, but low-birthweight data came from Australian Government Report, for 2012–2013 (Australian Government & Department of the Prime Minister and Cabinet, 2014). This report also supplied alcohol mortality and infant mortality in Australian subpopulations (Australian Government & Department of the Prime Minister and Cabinet, 2014).
- Markedly different rates for Australian breastfeeding at 6 months between 2010 and 2011 (Australian Institute of Health and Welfare, 2018).
- Pregnancy smoking data came from Li, Zeki, Hilder, and Sullivan (2013).
- Aborigine bedsharing data came from Cunningham, Vally, and Bugeja (2018).
- Australian Aborigine sleep position data came from Eades and Read (1999).

Canadian notes

- Subpopulation percentages came from the 2016 Canadian census.
- 2004–2006 SIDS rates for indigenous and nonindigenous Canadians came from Sheppard et al. (2017).
- Rates for SUID 1999-2011 for Inuit in Nunavut comes from Collins et al., 2012.
- Preterm birth rates for indigenous and nonindigenous Canadians came from Sheppard et al. (2017).
- 2004–2006 infant mortality rates for indigenous and nonindigenous Canadians came from Sheppard et al. (2017).
- Breastfeeding rates in indigenous Canadian and nonindigenous include Métis (McIsaac, Moineddin, & Matheson, 2015). Data are extremely sparse and do not appear to be collected routinely for these populations.
- Pregnancy smoking data came from Al-Sahab, Saqib, Hauser, and Tamim (2010) for 2006 and Cui, Shooshtari, Forget, Clara, and Cheung (2014) for 2010.
- Female smoking data for indigenous Canadians came from Physicians for a Smoke-Free Canada (2013) and Bougie and Kohen (2018).
- Sleep position in Inuit and Canada and bedsharing data in Inuit and Canada came from Collins et al. (2012).
- Bedsharing data from First Nation mothers came from Eni, Phillips-Beck, and Mehta (2014).

Japanese notes

- Japanese 2015 SIDS rates came from Ministry of Health Labour and Welfare (2016).
- Japanese pregnancy smoking data came from Yasuda et al. (2013).
- Japanese supine sleep and smoking rates from 2010–2011 came from Hirabayashi et al. (2016).
- Data on Japanese pre-school children having their own bed came from Mindell et al. (2013).

Dutch notes

- The Netherlands bedsharing and sleep position data came from (van Sleuwen, L'Hoir, Engelberts, Westers, & Schulpen, 2003).
- Smoking in pregnancy data came from (Zeitlin et al., 2012).

New Zealander notes

- NZ subpopulation data came from the 2017 NZ census.
- NZ SIDS and SUID data for 2002–2010 were calculated from Ministry of Health (2017a). SUID was defined by NZ government.
- NZ SUID 2014 data were calculated by adding R95, R99, and W75 from Ministry of Health (2017b).
- NZ subpopulation preterm birth data were taken from Ministry of Health (2012).
- 2014 infant mortality rates from NZ and subpopulations came from NZ government report (Ministry of Health, 2017b).
- NZ breastfeeding data for 2014 came from 2010–2015 data from Royal New Zealand Plunket Society (2017).
- Antenatal smoking rates from NZ and subpopulations (2010) came from Humphrey, Rossen, Walker, and Bullen (2016).
- UN did not publish Gini coefficient or quintile ratio for NZ. NZ Gini coefficient came from Ministry of Social Development (2016).
- Alcohol use in NZ subpopulations came from Ministry of Health (2004).
- Sleep position data came from Hutchison, Stewart, and Mitchell (2006).
- Māori bedsharing data came from Jones, Cornsweet Barber, Waimarie Nikora, and Middlemiss (2017).

Swedish notes

- Swedish data for 2002–2011 came from Möllborg et al. (2015), as Sweden was not included in the Taylor study. It is unclear if every case of SUID was included. Total live births in Sweden 2002–2011 numbered 762,626 came from Statistika Centralbyrån- Statistics Sweden (2018).
- Smoking in pregnancy data came from Zeitlin et al. (2012).
- Swedish 2010–2014 bedsharing and sleep position data came from Stromberg Celind et al. (2017).

U.K. notes

- U.K. (England and Wales) SIDS and SUID rates from 2014 and 2015 came from Patel (2017). The description notes they use linked birth/death data for R95 and R99 but do not mention W75. Thus, these may be gross underestimates for SUID.
- Smoking in pregnancy data came from Zeitlin et al. (2012).

- Bedsharing data among breastfeeding mothers (at least "intermittently" or "often") came from Ball et al. (2016), but there was insufficient data for 22% of respondents.
- Bedsharing and supine sleep data among the Bradford sample came from Ball et al. (2012).

U.S. notes

- White, Black, AI/AN, and Asian/PI are all "non-Hispanic."
- U.S. subpopulation census estimates came from 2016 census estimates and include both non-Hispanic and Hispanic (United States Census Bureau, 2018).
- SIDS rates for 2002–2010 for U.S. subpopulations were calculated from CDC WONDER (Centers for Disease Control and Prevention & National Center for Health Statistics, 2017). SIDS and SUID subpopulation data also came from CDC WONDER. SUID for 2014 was defined as R95, R99, and W75.
- Preterm birth rates in the United States and subpopulations came from US Department of Health and Human Services, Health Resources and Services Administration, & Maternal and Child Health Bureau (2012).
- SUID rates for U.S. subpopulations 2002–2010 were calculated from CDC WONDER using the same ICD-10 codes from Taylor et al. (2015): R95, R96, R98, R99, W75, W78, and W79 (Centers for Disease Control and Prevention & National Center for Health Statistics, 2017). Note, this gave a total SUID rate of 0.96.
- U.S. subpopulation infant mortality data (2014) came from National Center for Health Statistics (US) (2017).
- Breastfeeding data from U.S. subpopulations came from Centers for Disease Control and Prevention (2017a).
- Smoking in pregnancy data came from Child Trends Data Bank (2016).
- Female and male smoking rates for the United States and subpopulations for 2015 came from Jamal et al. (2016).
- Bedsharing and supine sleep data came from U.S. Pregnancy Risk Assessment Monitoring System data in 2015 (Bombard et al., 2018).
- Sofa-sharing data in U.S. Blacks came from mortality data in L. Li et al. (2009) and Unger et al. (2003).
- Second-hand smoke data in U.S. Blacks and smoking rates in U.S. subpopulations in U.S. Blacks came from CDC WONDER (Centers for Disease Control and Prevention, 2017b).
- CDC WONDER is the source for 2010–2014, among females, all ages, per 100,000 persons (Centers for Disease Control and Prevention & National Center for Health Statistics, 2017). Rates reflect all "Alcoholic Liver Disease" (ICD-10 codes K70.0, K70.1, K70.3, K70.4, and K70.9) to better approximate the values estimated by the WHO. When just the ICD-10 code for alcoholic cirrhosis is used, K70.3, the overall U.S. rate was 2.6, far lower than the WHO estimate. Using this code alone, rates for U.S. Blacks are 1.8, for AI/AN 14.6, for Whites 2.9, for Hispanics 2.0, and for Asian/PIs 0.3.

sharing (Blair et al., 2009). The association of SUID with social disadvantage was demonstrated in 51 of 52 case–control and cohort studies between 1965 and 2002 (Spencer & Logan, 2004), most of which were done before the Back to Sleep campaigns. This association was independent of maternal smoking in nine out of 10 studies (Spencer & Logan, 2004).

Anthropologists have used syndemics theory to describe similar patterns of disease clustering, wherein social inequities result in multiple, co-occurring epidemics that may interact to worsen some outcomes (Singer et al., 2017). These insights have generated a large body of research in population health, especially in examining the relationship of co-occurring psychosocial factors in the production of human immunodeficiency virus risk (Singer et al., 2017). Despite significant attention to SUID/SIDS, to date the clustering and social origins of co-occurring risk factors in marginalized populations has not been adequately theorized or examined in relation to sudden infant death. Our paper takes up this charge by examining patterns of co-occurring risk factors and protective factors in low-prevalence and high-prevalence settings for SUID/SIDS.

2 | METHODS

Using available public databases and the literature, we compared SIDS and SUID prevalence and their risk factors in Australia, Canada, Japan, New Zealand, the Netherlands, Sweden, the United Kingdom, and the United States, as well as specific subpopulations in Australia, Canada, New Zealand, and the United States. Because rates of SIDS and SUIDS are rapidly changing, mostly decreasing, and smoking rates are also rapidly decreasing, and preterm birth rates are decreasing, an effort was made to use those rates that are temporally aligned. For the United States, we used linked birth/death data, but these were not available or not labelled as such for New Zealand, Australia, Canada, or New Zealand.

In an effort to understand the high rates of SIDS and SUID in the United States, we used the Centers for Disease Control and Prevention WONDER interactive database, which allowed us to examine these rates by the month prenatal care began in the affected infants, per racial and ethnic group for SIDS and SUID. We examined the percentages of timely and late prenatal care in U.S. SUID/SIDS cases and in selected world populations. We calculated odds ratios with 95% confidence intervals on the odds of no and late prenatal care versus timely prenatal care for each U.S. racial or ethnic group on the odds of SIDS and SUID.

3 | RESULTS

See Tables 1–5 and literature below. Citations from the tables will not be repeated in the text.

3.1 | Low-prevalence populations

The lowest SIDS prevalence is found in the Netherlands, followed by Japan and Sweden, similar to previous data (Hauck & Tanabe, 2008). Asian Americans have the fourth lowest prevalence of SIDS among the populations we studied (Tables 1 and 2). Of these four populations with lowest prevalence of SIDS and SUID, three—Sweden, the Netherlands, and Japan—enjoy universal health care, and Sweden and the Netherlands have especially low-income inequality (Table 1).

TABLE 2 Rates of SIDS, ASSB, and SUID, 2014, in selected U.S. and New Zealand populations, per 1,000 live births

	SIDS	ASSB	SUID
U.S. American Indian/Alaskan Native	0.84	Not reliable	1.92
U.S. Blacks	0.74	0.52	1.70
New Zealand Māori	Not reliable	1.40	1.82
United States	0.39	0.21	0.87
U.S. Whites	0.38	0.20	0.82
New Zealand	0.24	0.52	0.75
U.S. Hispanic	0.24	0.11	0.54
New Zealand non-Māori	Not reliable	Not reliable	0.34
U.S. Asian	0.15	Not reliable	0.29

Note. SUID is defined as R-95, R-99, and W-75 (American Indian/Alaskan Native, Black, and White refer to non-Hispanics only). U.S. data are linked birth/death data. U.S. data came from Centers for Disease Control and Prevention and National Center for Health Statistics (2017). New Zealand data are not stated as being linked and came from Ministry of Health (2017a). Numbers were denominator is less than 20 are considered "not reliable." ASSB: Accidental Suffocation and Strangulation in Bed; SIDS: sudden infant death syndrome; SUID: sudden unexpected infant death.

Like every industrialized nation but the United States, they also have paid maternity leave. Asian Americans have relatively greater wealth compared with other U.S. groups—over twice the median household income of U.S. Blacks and 1.3 times that of Whites (Guzman, 2017).

Among Japanese, Swedes, and Asian Americans, both breastfeeding and bedsharing are very common (Table 1). Sweden had the highest bedsharing rate in all of Western Europe (Nelson et al., 2001), although it has decreased with recommendations against bedsharing (Stromberg Celind, Wennergren, Möllborg, Goksor, & Alm, 2017). With universal implementation of the Baby-Friendly Hospital Initiative, Sweden also has exceptionally high breastfeeding rates (Table 1). Sweden has half the pregnancy smoking rate of the United States (Table 1). In Japan, only 16.9% of pre-school-aged children have their own bed (or futon), and only 1.4% have their own room (Mindell, Sadeh, Kwon, & Goh, 2013), as family interdependence is strongly valued in contrast to Western values of child independence (Jenni & O'Connor, 2005). Japan also has high breastfeeding rates. Japan, however, has had historically very high male smoking rates (Table 1).

Compared with the above three low-prevalence populations, the Netherlands has lower breastfeeding, moderate preterm birth rates but low overall infant mortality (Table 1), suggesting overall excellent access to health care. Low pregnancy smoking rates compared with high population smoking rates may reflect that Dutch women have good access to prenatal care (Table 1), as such access has been shown to help pregnant women quit (Committee on Underserved Women & Committee on Obstetric Practice, 2017).

In the United Kingdom, which has a relatively low rate of SIDS, the proportion of SIDS deaths occurring in term infants has significantly decreased from 1984 to 2003 (Table 1), whereas the proportion in preterm infants has increased from 12% to 34% (Blair, Sidebotham, et al., 2006). Furthermore, the proportion of U.K. SIDS deaths occurring in families living in poverty has significantly increased from 47% to 74%, and the proportion of SIDS deaths in infants of mothers who smoked during pregnancy has significantly increased from 57% to 87% (Blair, Sidebotham, et al., 2006). In England and Wales, deprivation is a strong predictor of SUID (OR of 3.46 between the poorest and richest quintiles with 95% confidence interval 2.82-4.23), distributed similarly across ethnic groups (Kroll et al., 2018). The United Kingdom has exceptionally low rates of breastfeeding at 12 months compared with other industrialized nations (Victora et al., 2016). Current government SUID rates (see Table 1) do not include ASSB.

Canada and Australia may be becoming countries with the lowest rates of SIDS, but we would require SUID data to confirm that this is not merely diagnostic shift.

3.2 | High-prevalence populations

In 2010, the United States led the world's high-income countries in the rate of post-neonatal SUID, and the United States and New Zealand were tied for the world's highest rates of SIDS (B. J. Taylor et al., 2015), but by 2014, the United States had surpassed even New Zealand for both SIDS and SUID (Centers for Disease Control and Prevention & National Center for Health Statistics, 2017; Ministry of Health, 2017b). In 2014, U.S. AIs/ANs had the world's highest SUID rate and SIDS rate, whereas New Zealand Māori were the second in SUID (Table 2). U.S. AIs/ANs were the highest in the world in SIDS, followed closely by U.S. Blacks, whereas Māori were a distant third, much of it ASSB (Table 2). In 2010–2012, the Māori rate of SIDS was 3.5 times that of the non-Māori, which is as low as that of Sweden, one of the world's lowest (Ministry of Health, 2015). By 2014, this gap lowered to 2.5, but the SUID rate in Māori was still 5.4 times that in non-Māori (Ministry of Health, 2017b). The pregnancy smoking rate among European New Zealanders was just above that of Sweden. By contrast, in the United States, even the SUID/SIDS rates among Whites are very high, with SIDS rates nearly approaching those of Māori.

3.2.1 | New Zealand Māori

New Zealand's overall SIDS rates are now moderate. The Māori, however, continue to experience disproportionately high rates. Smoking rates among pregnant Māori are very high, and hazardous alcohol use is also comparatively higher among Māori (Table 1). New Zealand, like Sweden, has universal implementation of the Baby-Friendly Hospital Initiative. Overall breastfeeding initiation rates are higher than those in Sweden, but Māori rates appear to be significantly lower that of non-Māori (Table 1). Bedsharing is comparatively much more common among Māori (Table 1). Indeed, New Zealand researchers found the combination of smoking and bedsharing increased the risk of SUID 32-fold compared with infants with neither of these risks (Mitchell et al., 2017).

3.2.2 | United States

In the United States, unlike Australia, New Zealand, and Canada, rates of SIDS and SUID are high even in the White population but are markedly higher in the Black and AI/AN populations (Tables 1 and 2). Tables 3–5 show poor prenatal care is inversely associated with higher SIDS and SUID rates in a dose–response fashion for almost every U.S. ethnic group but most pronounced in Whites, Asians, and Hispanics (SUID only).

U.S. Blacks

Average U.S. Black family income is significantly lower than that of Whites, and U.S. Blacks continue to experience pervasive racism as

TABLE 3 U.S. SIDS and SUID rates per 1,000 live births, by subpopulation and by month prenatal care started, 2010–2015

Population	SIDS, no prenatal care	SIDS, third trimester	SIDS, second trimester	SIDS, first trimester	SIDS, overall	SUID, no prenatal care	SUID, third trimester	SUID, second trimester	SUID, first trimester	SUID, overall
U.S. overall	1.03	0.74	0.62	0.32	0.43	2.50	1.53	1.28	0.67	0.88
Black	1.37	0.98	0.96	0.62	0.80	3.72	2.30	2.13	1.40	1.58
AI/AN	Unreliable	Unreliable	1.29	0.85	1.00	Unreliable	2.33	2.48	1.88	1.98
White	1.27	0.82	0.68	0.33	0.43	2.65	1.71	1.37	0.66	0.72
Hispanic	0.46	0.43	0.34	0.19	0.25	1.43	0.81	0.71	0.40	0.72
Asian/PI	Unreliable	0.42	0.24	0.13	0.17	Unreliable	0.65	0.45	0.26	0.29

Note. Figures in which the numerator is under 20 are deemed as "unreliable." Overall figures include infants for whom prenatal care was not listed on certificate or those whose prenatal care status was listed as "excluded." Black, AI/AN, White, and Asian/PI are all non-Hispanic. AI/AN: American Indian/Alaskan Native; PI: Pacific Islander; SIDS: sudden infant death syndrome; SUID: sudden unexpected infant death. *Source*. CDC WONDER linked birth–death records (Centers for Disease Control and Prevention & National Center for Health Statistics, 2017), using R95 (SIDS) and (SUID).

TABLE 4 Percentage of SIDS and SUID cases that received timely (i.e., first trimester) prenatal care or late (third trimester) or no prenatal care, by racial/ethnic group, and overall prevalence of late or no prenatal care

Population	SIDS cases with timely prenatal care, 2010–2015 (%)	SUID cases with timely prenatal care (%) 2010–2015	Prevalence of timely prenatal care (%)	SIDS cases with late or no prenatal care, 2010–2015 (%)	SUID cases with late or no prenatal care (%), 2010–2015	Prevalence of late or no prenatal care (%)
U.S. overall	45.1	46.0	74.1 (2012)	9.1	9.9	6.0 (2014)
U.S. Black	38.3	39.6	63.6 (2012)	10.4	11.8	4.3 (2014)
U.S. AI/AN	37.9	30.3	59.4 (2012)	12.1	12.0	10.8 (2014)
U.S. White	48.7	49.8	79.0 (2012)	7.4	7.6	5.2 (2014)
U.S. Hispanic	53.9	32.8	69.0 (2012)	14.3	8.6	7.5 (2014)
U.S. Asian/PI	50.2	50.1	78.0 (2012, Asian only)	10.6	9.4	5.7 (2014)
Australia			65 (2015)			
Australian indigenous			57 (2015)			
Australian nonindigenous			63 (2015)			
Japan						0.3 (no care 2009)
The Netherlands			87.3 (2010)			6.2 (2010)
United Kingdom: England			77.6 (2010)			9.6 (2010)
United Kingdom: Scotland			87.3 (2010)			2.3 (2010)

Note. Black, AI/AN, White, and Asian/PI are all non-Hispanic. AI/AN: American Indian/Alaskan Native; PI: Pacific Islander; SIDS: sudden infant death syndrome; SUID: sudden unexpected infant death. *Source*. CDC WONDER for SIDS and SUID cases 2010–2014 (Centers for Disease Control and Prevention & National Center for Health Statistics, 2017). U.S. data came from Child Trends Data Bank (2015). England, Scotland, and the Netherlands data came from Euro-PERISTAT (Zeitlin, Mohangoo, & Delnord, 2012). Japanese data came from Unno (2011). Australian data came from Australian Institute of Health and Welfare (2015). Timely prenatal care is defined as first trimester; late prenatal care is defined as third trimester.

TABLE 5 ORs of the effect of no/late prenatal care to first trimester prenatal care to SIDS/SUID, by U.S. racial/ethnic group

Population	OR no prenatal care/first trimester care (95% confidence interval), SIDS	OR third trimester prenatal care/first trimester care (95% confidence interval), SIDS	OR no prenatal care/first trimester care (95% confidence interval), SUID	OR third trimester prenatal care/first trimester care (95% confidence interval), SUID
Black	2.20 (1.80, 2.68)	1.58 (1.35–1.85)	2.66 (2.36, 3.00)	1.65 (1.49, 1.82)
AI/AN	*1.36 (0.55, 3.34)*	*1.12 (0.65, 1.93)*	*1.59 (0.90, 2.79)*	*1.24 (0.87, 1.77)*
White	3.87 (3.24, 4.61)	2.49 (2.21, 2.81)	4.04 (3.57, 4.57)	2.60 (2.39, 2.83)
Hispanic	2.94 (2.23, 3.89)	0.67 (0.36, 0.54)	3.59 (3.01, 4.27)	2.01 (1.74, 2.33)
Asian/PI	2.88 (1.07, 7.81)	3.15 (2.02, 4.91)	4.43 (2.48, 7.92)	2.45 (1.72, 3.49)

Note. Black, AI/AN, White, and Asian/PI are all non-Hispanic. Numbers in italic indicate failure to reach statistical significance. AI/AN: American Indian/Alaskan Native; OR: odds ratio; PI: Pacific Islander; SIDS: sudden infant death syndrome; SUID: sudden unexpected infant death. Source of prenatal care came from Centers for Disease Control and Prevention and National Center for Health Statistics (2017).

discussed above (United States Department of Labor Women's Bureau, 2015). Although overall smoking rates are often equal to or lower than those in the countries with lowest SIDS/SUID rates, Black children have significantly greater exposure to second-hand smoke: 67.9% compared with 37.2% for White children (2011–2012; Homa et al., 2015). Black parents are more likely to place infants to sleep prone and more likely to sleep with their infants outside an adult bed, such as a sofa (Unger et al., 2003). One Maryland study showed nine of 10 co-sleeping asphyxia deaths were in Black infants, most commonly on sofas, even though all homes had cribs (Z. Li, Zhang, Zielke, Ping, & Fowler, 2009). Finally, Blacks have the lowest breastfeeding rates of any U.S. ethnic group. Suboptimal breastfeeding rates among non-Hispanic Blacks were determined to contribute to 1.95 the risk of SIDS in that population compared with non-Hispanic Whites (Bartick et al., 2017a).

U.S. American Indians/Alaskan Natives

AI/AN median income is 69% that of the general population, and 27% live in poverty, the highest of any ethnic group (US Census Bureau, 2016), reflecting historical trauma enacted by colonization, and continued racism and discrimination. AIs/ANs have high rates of smoking and alcohol use. Bedsharing is comparatively more common than among Whites (Table 1). Breastfeeding rates are the second lowest of U.S. ethnic groups after Blacks. Recognizing this problem, in 2014, all Indian Health Service Hospitals became Baby-Friendly. However, Indian Health Service facilities only serve just over half of AIs (U.S. Department of Health and Human Services & Indian Health Service, 2018).

3.2.3 | First Nation and Inuit in Canada

Although SIDS has declined in Canada overall, SIDS was the leading cause of infant mortality in First Nation and Inuit populations in 2004–2006 (Sheppard et al., 2017). These populations also have similar experiences of historical trauma and poverty and have very high smoking rates and comparatively lower breastfeeding rates, and the Inuit have extremely high preterm birth rates. The Canadian government does not appear to routinely collect or publish infant health metrics by ethnicity. Bedsharing is very common in the Inuit communities and among breastfeeding First Nation mothers (Table 1). The combination of marginalization, poverty, and smoking in combination with bedsharing with lower breastfeeding rates and poor access to prenatal care, especially in remote areas, likely contribute to the high death rate.

3.2.4 | Australian Aborigine and Torres Strait Islanders

Australian Aborigine and Torres Strait Islanders are by far the most socio-economically disadvantaged subgroup in the Australian population with the worst overall health outcomes (Australian Government & Department of the Prime Minister and Cabinet, 2014; Greenhalgh, Bayly, & Winstaley, 2017). They have high rates of smoking with moderate bedsharing and comparatively lower rates of breastfeeding. In one study, 81% of Aboriginal infants were placed on their sides to sleep, and only 8% were placed on their backs (Eades & Read, 1999). The combination of poverty, high incidence of low-birthweight infants, smoking paired with bedsharing, and lower breastfeeding and racial discrimination likely explains high SUID/SIDS prevalence.

In the marginalized subpopulations in all four countries studied, the preterm birth rate or low-birthweight rate outpaces that of the ethnically dominant populations, although less so in New Zealand. This is not mediated only by smoking as there are similar preterm birth rates in the Netherlands and among Māori despite many times the pregnancy smoking rate among Māori and very high rates among U.S. Blacks with moderate pregnancy smoking rates. This suggests other complex factors related to access to care, poverty, and racism may be playing a role, as supported by a previous analysis (Spencer & Logan, 2004).

4 | DISCUSSION

To our knowledge, this is the first work to employ syndemics theory to conceptualize and systematically examine the distribution of SIDS and SUIDS and the clustering of its risk factors in relation to underlying social inequities.

Our findings reflect the importance of social drivers of SUID/SIDS rates. Low-prevalence populations generally have better health care and less inequality, which is also linked to lower prevalence of poverty and fewer harmful health behaviours. In contrast, several high-prevalence populations have experienced historical trauma and racism and continue to experience high rates of poverty, poorer access to high quality health care, and comparatively higher harmful health behaviours. The legacy of historical trauma plays an enduring role for generations of marginalized peoples. Australian Aborigines, Māori, AIs, First Nation and many Inuit, and AN people have all had their lands confiscated and their traditional ways of life destroyed or upended by European colonization, and their populations decimated by European diseases to which they had no immunity. These communities also experience high rates of poverty and poorer health due to these historical legacies. Structural racism persists long after the end of slavery for African Americans, with generations left in poverty due to federal laws all but prohibiting purchasing of real estate and accumulation of generational wealth, as but one of many examples (Coates, 2014).

The specific pathways in the socially driven accumulation of co-occurring factors and their interplay are very complex and require additional study. It is not clear whether these factors produce poor outcomes via only co-occurrence or whether they interact in a synergistic manner, meeting the current definition of a syndemic (Tomori et al., 2018). Multiple statistical approaches are available for examining the accumulation and potential interactions among co-occurring risk factors (Tomori et al., 2018; Tsai, 2018; Tsai, Mendenhall, Trostle, & Kawachi, 2017). Future syndemics studies of SUID/SIDS should combine these quantitative approaches with in-depth qualitative studies to gain better understanding of the production of risk and to develop more effective prevention interventions.

Our findings clearly indicate that factors that worsen income inequality, poverty, and racial marginalization can be expected to increase infant mortality. The United States has now surpassed New Zealand as the world's leader in SIDS and SUID. The United States

has experienced worsening income and educational inequality over the past several decades (Greenstone, Looney, Patashnik, Yu, & The Hamilton Project, 2013), along with concomitant rises in housing prices, which are now at a historical high percentage of income (Kotkin, 2017). Additionally, inadequate government assistance to the poor further contributes to poverty. For example, U.S. food stamp benefits do not cover the cost of meals in 99% of U.S. counties (Dewey, 2018). In 2016, 41% of U.S. children were either poor or near poor (Koball & Jiang, 2018). U.S. infant mortality (5.9) exceeds the high-income country average of 5.3 per 100,000. Our data suggest that lack of prenatal care may play a large role in the high death rates even among U.S. Whites, although it is difficult to know if this is a marker for poverty as well as playing a causal role.

U.K. statisticians attribute their decrease in smoking directly to the drop in SUID rates (Patel, 2017), and this may be the case in other countries. However, smoking rates have declined in the United States, whereas SUID rates have not, possibly because gains in smoking cessation and breastfeeding are offset by factors related to rising poverty and persistent racial discrimination.

Infant mortality is considered a metric for the health of a society. In the United States, SIDS is the third largest component of infant mortality after preterm birth and congenital anomalies (Centers for Disease Control and Prevention, 2018). The high U.S. SIDS/SUID rates serve as a "canary in the coal mine" that U.S. society has unacceptable social policies with regard to poor families and pregnant women and particularly women of colour. The United States has neither paid maternity leave nor universal health care and by far the highest metrics for income inequality. These factors can be expected to affect all segments of the population that are economically disadvantaged. In 2013, nearly 20% of U.S. women had no health insurance just before they became pregnant, and about 14% had none post-partum (Centers for Disease Control and Prevention, 2017).

Risk factors may compound one another or work to offset one another. The combination of bedsharing, high breastfeeding rates, low pregnancy smoking rates, and excellent access to care may result in very low infant death rates even with modest societal tobacco use, as in Sweden and Japan. By the same token, higher pregnancy smoking and bedsharing rates, even with good access to care, may result in increased risk of SUID/SIDS (Māori). Although bedsharing can be part of the cluster that produces higher SUID/SIDS prevalence, it can also be an important part of a set of protective behaviours, like breastfeeding.

The risk factors for the two biggest preventable causes of infant mortality, preterm birth and SIDS, largely overlap. These conditions should not be siloed, and undue focus on bedsharing at the expense of emphasis on tobacco exposure, prenatal care, and amelioration of poverty and racial discrimination will fail to result in sufficient reductions in infant mortality. Adverse health outcomes are related to income inequality, structural racism for those countries with populations of marginalized groups, and social safety nets play an important role for vulnerable populations in addressing children's health. Parallel efforts to reduce preterm birth, including reducing antenatal smoking, will also help reduce infant death associated with co-sleeping and other causes.

Finally, given the role of numerous societal factors in the multiple interplaying risk factors for infant death, recommendations to individual parents and health care providers must be accompanied by recommendations for social policy makers in order to affect any meaningful change the rate of infant death. Individuals should not be expected to reverse burdens placed on them by history and an inequitable social structure. Medical organizations' recommendations depend on individuals to take individual action, but as the problem of SUID/SIDS is much greater than the actions of any of individual, some solutions must ultimately originate from the policy level.

New Zealand has been successful in markedly bringing down both SIDS and SUID rates since 2009 (Ministry of Health, 2017a), and they should be looked at as a leader in this field, although marked disparities continue. Some success is undoubtedly attributable to the Wahakura and Pepi-Pod on-the-bed sleeping devices (Abel & Tipene-Leach, 2013). The Wahakura was inspired by a revival of traditional Māori sleeping devices and was developed by and with the Māori community (Baddock et al., 2017; Bartholomew, 2017). Nearly all hospitals are now Baby-Friendly. The government collects and makes public all data on Māori and other minority groups for nearly every health metric examined here. New Zealand has also implemented a large stepwise tobacco tax as of 2017 (Radio New Zealand, 2017). The similar rates of preterm birth among the Netherlands and Māori may also represent success of the New Zealand maternity care system, where access to prenatal care is nearly equal between Māori and non-Māori (Ministry of Health, 2012), illustrating success in preventing preterm births despite having twice the pregnancy smoking rate.

4.1 | Limitations

This study is limited by the instability of the rates SIDS, SUID, and smoking in most of the populations studied. There may be diagnostic shift away from SIDS, as well as lowering of SUID due to the secular trend in lower smoking rates. In addition, different countries may code infant deaths differently. Female alcohol-related deaths may not adequately reflect current levels of hazardous drinking among new mothers nor among co-sleeping fathers. There is no universal consistent definition of nearly every term in Table 1, and neither the Australian government nor the U.K. (England/Wales) government definitions of SUID include ASSB (W75). Even SIDS has no consistent definition across localities. We did not examine every risk factor for SUID/SIDS, such as pacifiers or swaddling. Within the bedsharing and sleep position statistics, variability exists that may further influence outcomes, such as sofa sharing, degree of usual bedsharing, and side versus prone sleep.

4.2 | Recommendations

4.2.1 | Structural interventions to reduce risk and enhance protective behaviours

Smoking

Although smoking rates are declining and are lower in the United States than in some other countries, incremental change will help make bedsharing safer and reduce infant death. Tobacco-mediated

infant death is thus best prevented by proven population-based tobacco control interventions in addition to individual smoking cessation advice and supportive interventions. Tobacco prices are most sensitive among younger and lower income people. Data from over 53 million births across 24 European countries showed that a price increase of $1.18 per pack of cigarettes was associated with a decline of 0.23 deaths per 1,000 live births in the same year and 0.16 deaths per 1,000 live births the following year (Filippidis, Laverty, Hone, Been, & Millett, 2017). Relief of stressful living conditions, directly linked to poverty and racism, would also be important to recognize. Therefore supportive, rather than stigmatizing, interventions are needed.

On the basis of "strong evidence," the Community Preventive Services Task Force (2017) of the Centers for Disease Control and Prevention recommends increases in the unit price for tobacco as a means to decrease tobacco use. Interestingly, price increases are not even mentioned as a possible strategy either by the AAP tobacco prevention policy statement (Farber, Groner, Walley, Nelson, & Section On Tobacco, 2015) or by the American Cancer Society's Tobacco Atlas (Eriksen, Mackay, Schluger, Gomeshtapeh, & Drope, 2015).

Sidecars and on-the-bed sleeping devices such as Wahakura or Pepi-Pods may minimize smokers' exposure to their infants in bed or prevent asphyxiation and SIDS. Their use should be further explored for acceptance, safety, and efficacy.

Breastfeeding

Governments and non-governmental organizations can help improve breastfeeding rates through investments and policies. Both Sweden and New Zealand have mandated and supported all hospitals to become Baby-Friendly, and in the United States, publicly funded and privately funded efforts are targeting hospitals in parts of the country with the greatest breastfeeding disparities to become Baby-Friendly. As a result, breastfeeding rates have been proportionally increasing among African American and AI populations. Paid leave, peer counselling, and access to culturally appropriate breastfeeding support are important. Equally important are medical and governmental policies that do not undermine breastfeeding, such as policies that inappropriately demonize bedsharing, or allow aggressive marketing of infant formula.

Building a social safety net and addressing racism

The most challenging social causes of risks to modify are poverty and racism. Infants, young children, and their families are among society's most vulnerable members, and infant health begins during pregnancy. Housing and food insecurity, poor access to prenatal care, smoking, and poor breastfeeding support all contribute to adverse health outcomes seen. At a minimum, pregnant women and families need safe, stable housing and food security in order to maximize the chances for health of their children. They also need universal access to health care and paid parental leave. Access to care may help educate and ameliorate high-risk sleeping situations, as well as decrease the risk of poor birth outcomes.

Finally, ongoing efforts must bring the legacies of colonialism to light, as in the case of the Truth and Reconciliation Commission of Canada (2015), and continue to systematically address racism and social inequities. Although raising tobacco prices and breastfeeding may augment these ongoing trends in the United States, the United States may not see further reduction in reducing infant mortality until there are substantive changes that affect poverty, inequity, and racial discrimination. Indeed, without such changes, infant mortality in the United States can reasonably be expected to rise.

5 | CONCLUSIONS

A syndemics analysis of SUID shows that it is primarily a condition of poor and marginalized populations who continue to cope with the legacies of historical trauma. SUID has many of the same risk factors as preterm birth. Smoking, poverty, alcohol/drug use, low breastfeeding rates, and unsafe sleep environments are common mediators of SUID and SIDS. A coordinated emphasis on reducing infant mortality by reducing tobacco use and preterm birth, addressing poverty and disparities, and promoting breastfeeding would be much more effective than addressing SUID and SIDS in isolation. Misplaced emphasis on individual behaviour practices like bedsharing, rather than on these combined factors, will not be expected to lower infant mortality. The United States stands out with its stagnant and high mortality rates and its increasing income inequality, high levels of child poverty, and the dismantling of the social safety net. These factors can reasonably be expected to result in increasing U.S. SUID/SIDS and overall infant mortality rates in the future. Medical organizations play an important role in advocating for broad social policy change. The alarmingly high rate of preterm birth and SUID throughout most of the U.S. population should serve as a call to action to reduce poverty, improve the social safety net, and ensure health care for all.

CONFLICTS OF INTEREST

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CONTRIBUTIONS

MB and CT together conceived this project. MB was responsible for conducting the analyses and constructing the initial draft and tables. CT provided social scientific theoretical expertise, worked together with MB to interpret findings, and shaped and edited the manuscript.

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